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Developmental changes in sensory-evoked optical intrinsic signals in the rat barrel cortex

Sintsov M., Suchkov D., Khazipov R., Minlebaev M.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2017 Sintsov, Suchkov, Khazipov and Minlebaev. Optical Intrinsic Signal imaging (OISi) is a powerful technique for optical brain studies. OIS mainly reflects the hemodynamic response (HR) and metabolism, but it may also involve changes in tissue light scattering (LS) caused by transient cellular swelling in the active tiss ue. Here, we explored the developmental features of sensory-evoked OIS in the rat barrel cortex during the first 3 months after birth. Multispectral OISi revealed that two temporally distinct components contribute to the neonatal OIS: an early phase of LS followed by a late phase of HR. The contribution of LS to the early response was also evidenced by an increase in light transmission through the active barrel. The early OIS phase correlated in time and amplitude with the sensory-evoked electrophysiological response. Application of the Modified Beer-Lambert Law (MBLL) to the OIS data revealed that HR during the early phase involved only a slight decrease in blood oxygenation without any change in blood volume. In contrast, HR during the late phase manifested an adult-like increase in blood volume and oxygenation. During development, the peak time of the delayed HR progressively shortened with age, nearly reaching the stimulus onset and overlapping with the early LS phase by the fourth postnatal week. Thus, LS contributes to the sensory-evoked OIS in the barrel cortex of rats at all ages, and it dominates the early OIS phase in neonatal rats due to delayed HR. Our results are also consistent with the delayed blood oxygen level dependent (BOLD) signal in human preterm infants.

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Keywords

Barrel field, Development, Hemodynamic response, Light scattering, Neonatal, OIS, Rats, Transparency

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